Earth Science and Applications

Discussion with Conservation Organizations on Future Satellite Missions

Earth Science Division
NASA Headquarters

10-November-2010

Discovering and Demonstrating Innovative and Practical Applications of Earth Science

The past 10^{+} years have demonstrated numerous opportunities for direct, applied uses of data from Earth science and environmental satellites across a spectrum of users & organizations.

- 8M data products in 2000; 250M in 2009 (30x Increase)

Communities and user organizations with potential uses of NASA Earth satellite data have opportunities to be involved early in the mission design and development stages for planned and future satellite systems.

- better preparation to manage data from the missions
- better able to develop data products for wider user types

Overall, NASA is promoting engagement with user communities to imagine, identify, and anticipate potential applications and benefits sooner from the nation's investments in NASA Earth science and environmental satellites.

Presentation Topics

NASA Earth Science

Earth Science Missions

Workshop Purpose and Possible Topics for Discussion

NASA and Earth Science

Earth Science Division

NASA is primarily a research and development agency.

The NASA Earth Science Division supports research on the Earth system and its processes. Primary efforts are to characterize, understand, and improve predictions of the Earth system.

In the course of performing its research, NASA collects observations and generates new scientific knowledge that can be applied to meet organizations' decision-making activities.

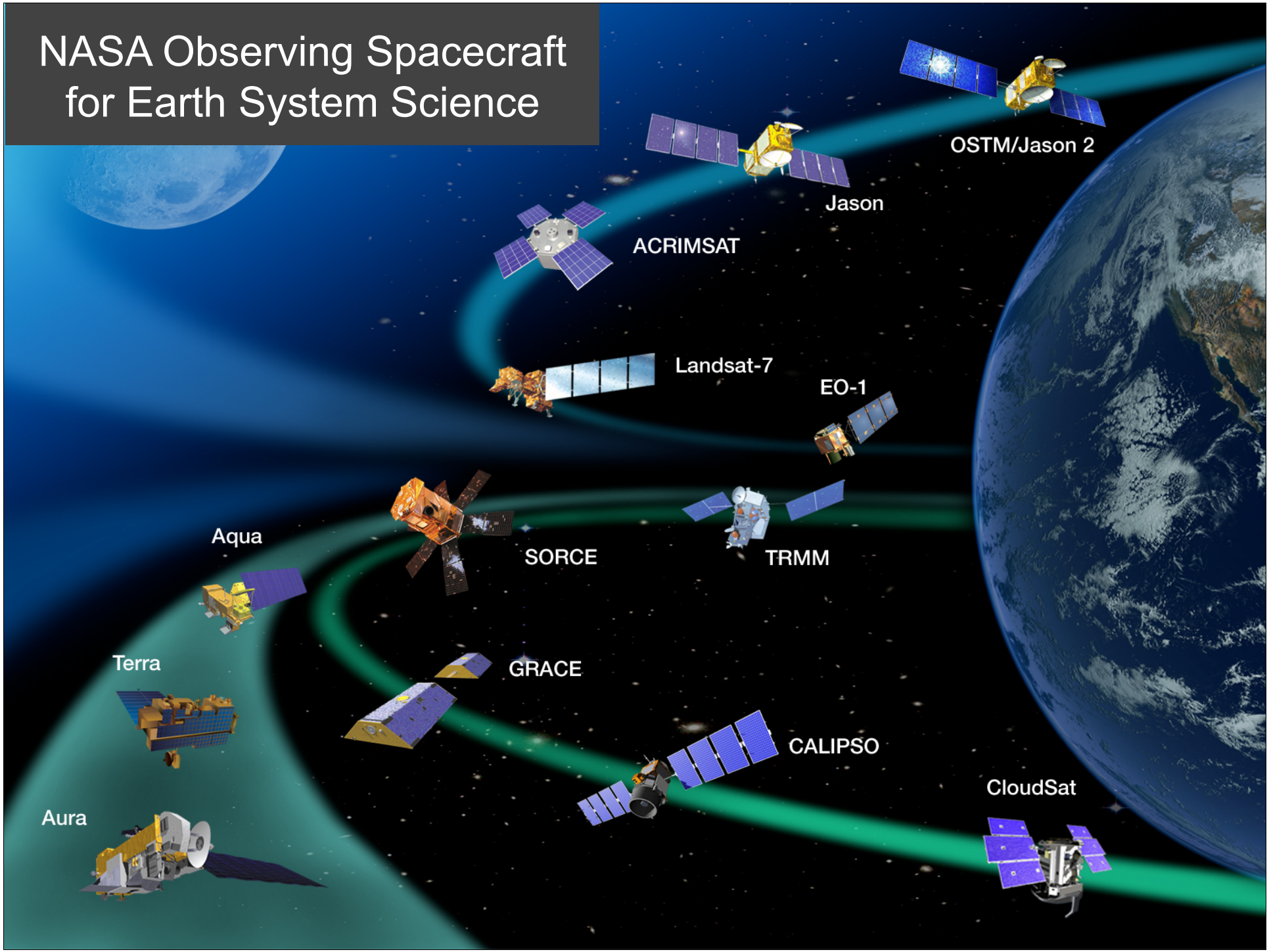
Technology

Missions

Research

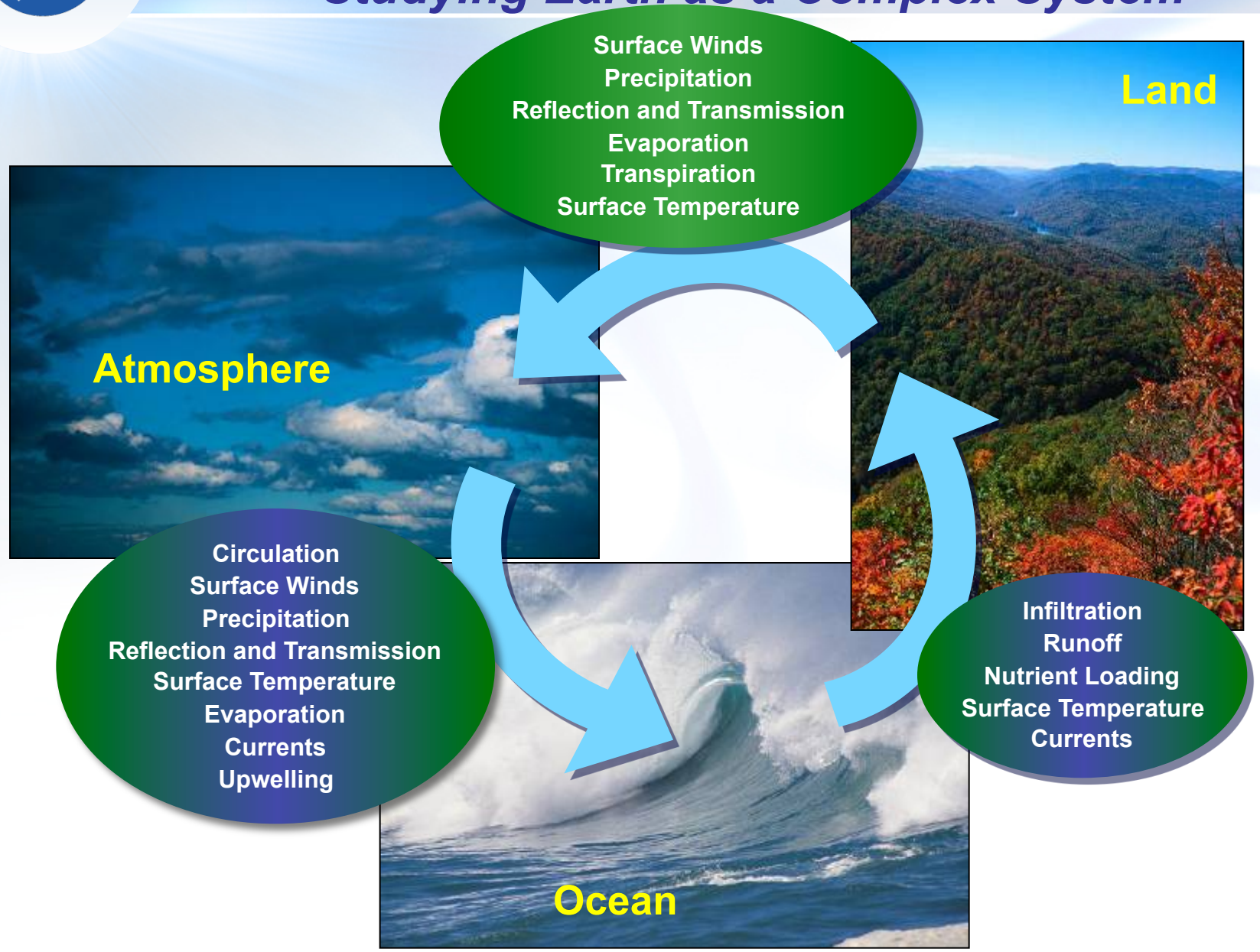
Data Systems

Applications


NASA Observing Spacecraft
for Earth System Science
OSTM/Jason 2
Jason
ACRIMSAT
Landsat-7
EO-1
Aqua
SORCE
TRMM
Terra
GRACE
CALIPSO
CloudSat
Aura

NASA and Earth Science

Studying Earth as a Complex System



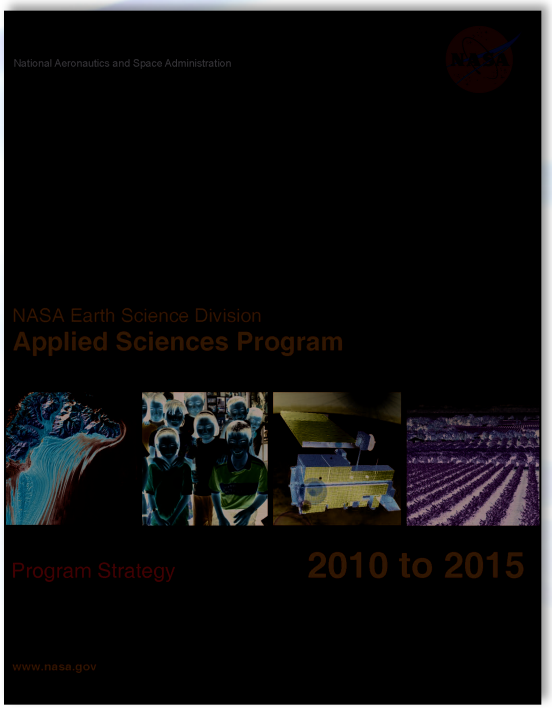
Applied Sciences Program

Program Strategy: Goals & Actions

Goal 1: Enhance Applications Research

Advance the use of NASA Earth science in policy making, resource management and planning, and disaster response.

Key Actions: Identify priority needs, conduct applied research to generate innovative applications, and support projects that demonstrate uses of NASA Earth science.



Goal 2: Increase Collaboration

Establish a flexible program structure to meet diverse partner needs and applications objectives.

Key Actions: Pursue partnerships to leverage resources and risks and extend the program's reach and impact.

Goal 3: Accelerate Applications

Ensure that NASA's flight missions plan for and support applications goals in conjunction with their science goals, starting with mission planning and extending through the mission life cycle.

Key Actions: Enable identification of applications early in satellite mission lifecycle and facilitate effective ways to integrate end-user needs into satellite mission planning.

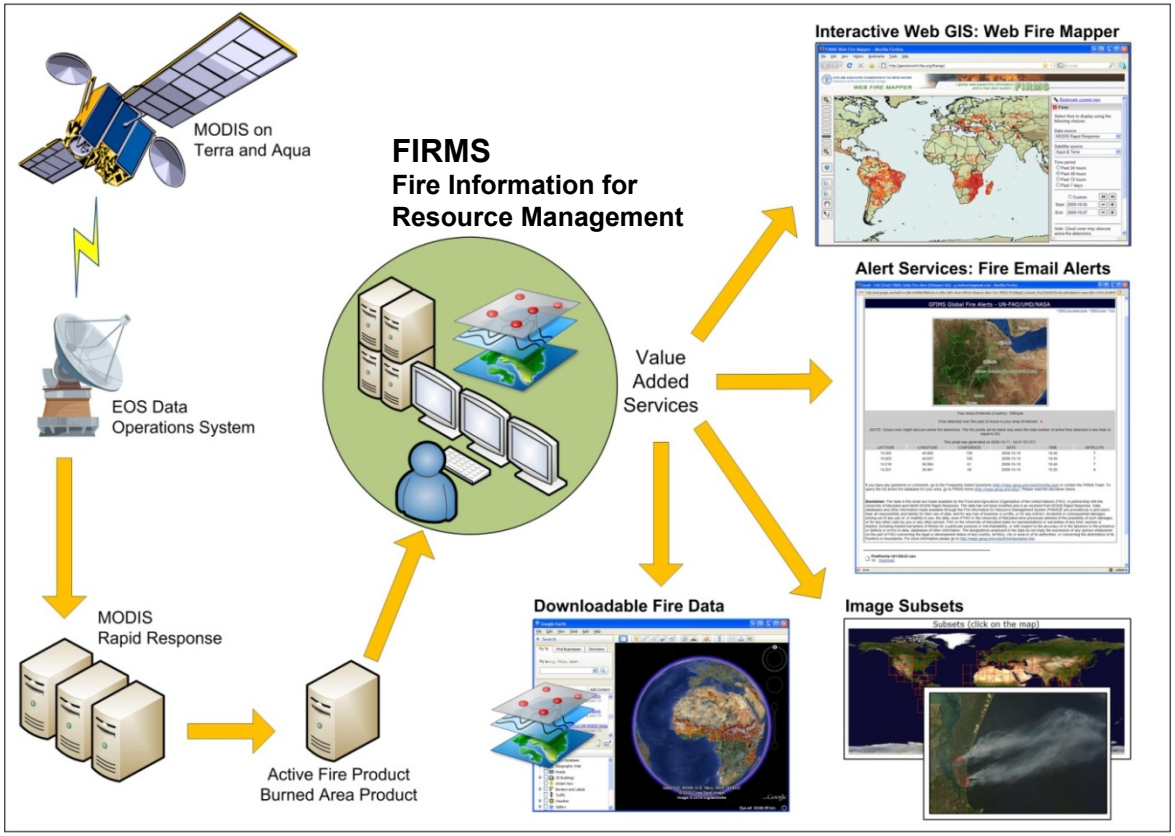
Fire Information for Resource Management System (FIRMS)

Challenge: Fire managers around the world need timely information on fires still burning in and around their areas of responsibility in order to manage response.

- **FIRMS** provides the MODIS-derived fire information in small, easy to use formats through the internet and fire email alerts.
- In doing so, FIRMS has increased the number and range of users that access these data.
- FIRMS users are the United Nations Food and Agriculture Organization, conservation organizations, other subscribers.

Capacity to detect large fires globally (day and night) at spatial scales allowing for timely local and regional management.

Fire Information for Resource Management System (FIRMS) (http://maps.geog.umd.edu/firms/)

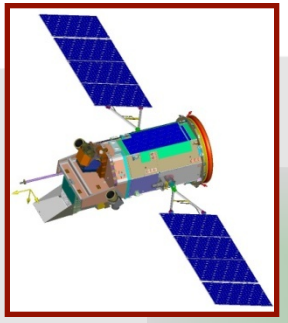


- **Interactive Web GIS**
- **Email alerts**
- **Subsets of MODIS images**
- **Active fire data downloads** (KML, Shape, Text files and plug-ins for Google Earth and NASA World-Wind)

August 2010:
UN Food & Agriculture Organization (FAO) launches its Global Fire Information Management System (GFIMS)

Satellite Missions

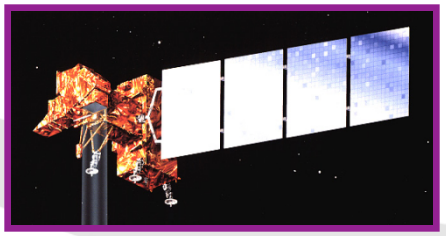
ESD Missions in Development & Formulation



GLORY
Feb 2011
Phase D

AQUARIUS
Jun 2011
Phase D

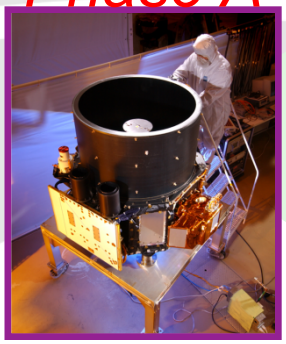
NPP
Sep 2011
Phase D



Phase C LDCM
Dec 2012

DESDynI
Lidar & Radar
2017

Phase A

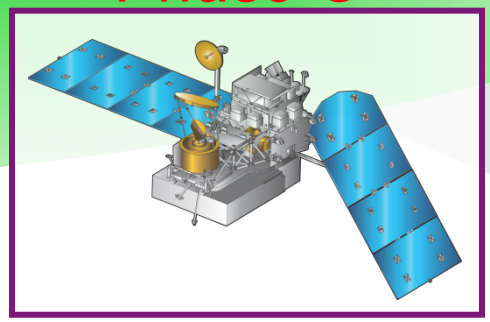


ICESat-2
Oct 2015

Phase B

SMAP
Nov 2014

Phase C



GPM
Jul 2013 Nov 2014

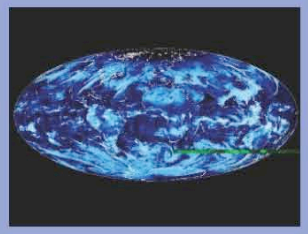
Phase B

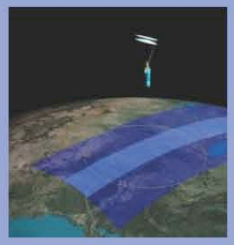
OCO-2
Feb 2013

Decadal Survey Missions

Tier I

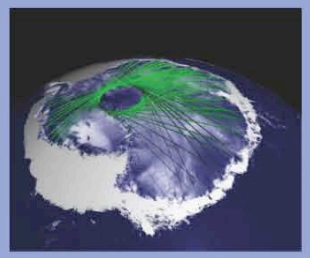
Climate Absolute Radiance and Refractivity Observatory **(CLARREO)**





Soil Moisture Active Passive **(SMAP)**

Ice, Cloud,and land Elevation Satellite II **(ICESat-II)**

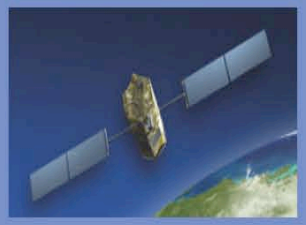


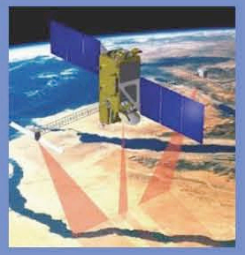
Deformation, Ecosystem Structure and Dynamics of Ice **(DESDynI)**

Tier II

Hyperspectral Infrared Imager **(HYSPIRI)**

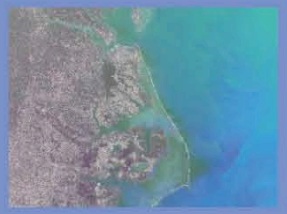
Active Sensing of CO2 Emissions **(ASCENDS)**

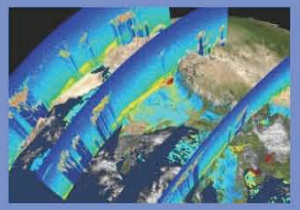




Surface Water and Ocean Topography **(SWOT)**

Geostationary Coastal and Air Pollution Events **(GEO-CAPE)**

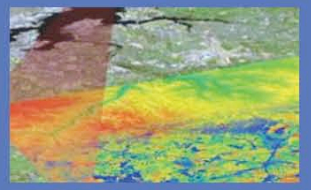




Aerosol - Cloud - Ecosystems **(ACE)**

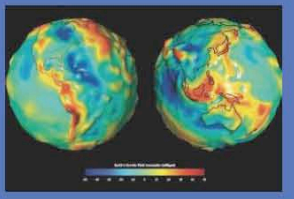
Tier III

LIDAR Surface Topography **(LIST)**



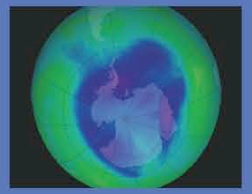
Precipitation and All-Weather Temperature and Humidity **(PATH)**

Gravity Recovery and Climate Experiment - II **(GRACE - II)**



Snow and Cold Land Processes **(SCLP)**

Three-Dimensional Winds from Space Lidar **(3D-Winds)**



Global Atmospheric Composition Mission **(GACM)**

NASA Earth Science

Some Terminology

Formulation, Approval, Implemenation, and Evaluation		
Formulation	Phase A	Concept and Technology Development
	Phase B	Preliminary Design and Technology Completion
Approval	*Transition to Implementation*	
Implementation	Phase C	Final Design and Fabrication
	Phase D	System Assembly, Integration and Test, and Launch (through on-orbit checkout)
	Phase E	Operations and Sustainment (including analysis and publication and delivery of data)
	Phase F	Close out

Formulation & Development, Product Definition, Algorithm Development

Operations, Product Refinement, Full Capability Utilization

Mission Requirements for Pre-Phase A

Scope of Major Pre-Phase A Activities:

Headquarters

- Approve a Formulation Authorization Document
- Develop DRAFT Level 1 Requirements
- Conduct Acquisition Strategy Planning Meeting

Technical Activities:

- Develop and document preliminary mission concepts
- Conduct internal Reviews
- Conduct Mission Concept Review Project Planning, Costing and Scheduling
- Develop and document a DRAFT Integrated Baseline, including:
  - High level WBS
  - Assessment of Technology Readiness Levels
  - Assessment of Infrastructure and Workforce needs
  - Identification of potential partnerships
  - Identification of conceptual acquisition strategies for proposed major procurements

KDP Readiness

- Obtain KDP A Readiness products
- Approval through the governing PMC

Areas for Mission Science Team

- Development of Level 1 Science Requirements
- Support development of preliminary mission concepts
- Support the assessment of Technical Readiness Levels
- Identify potential partnerships

Areas for Applied Science Community

- Initiate assessments of potential applied science returns
- Caucus community and partner input
- Support cost benefit analyses for possible requirements modifications to enable critical applications

Mission Requirements for Phase A

Scope of Major Phase A Activities:

Headquarters
- Establish Baseline Level 1 Requirements
- Conduct Acquisition Strategy Meeting
- Initiate Interagency and International Agreements

Technical Activities:
- Develop preliminary system level requirements
- Develop/document Baseline Mission Concept
- Develop preliminary mission operations concept
- Initiate technology developments
- Develop initial orbital debris assessment
- Conduct System Requirements Review
- Conduct Mission Definition Review

Project Planning, Costing and Scheduling:
- Prepare a preliminary Project Plan
- Conduct required Integrated Baseline Reviews
- Develop/document preliminary Integrated Baseline
- Identify Export Controlled technical data

KDP Readiness:
- Obtain KDP B Readiness products
- Approval through the governing PMC

Areas for the Mission Science Team:
- Concur with Level 1 Science Requirements
- Support development of preliminary system-level requirements
- Support development of mission baseline concept
- Support Development of preliminary mission operation concept

Areas for Applied Science Community:
- Refine applications feasibility studies
- Participate in science team analysis of refined level 1 requirements
- Support focused applications workshop

Science Questions & Societal Benefits Returns Drive Expectations

- The addition of all the new activities have increased the expected throughput of information for 2015 and beyond
- The expectation is for quicker data usability, easier portability and more transparency
- State of Earth *System* science is demanding more fusion data products faster
- Operational users need a better understanding of what the higher level products will be, when they will have them, and how long they will continue
  - This places an emphasis on *product* continuity as opposed to *mission* continuity
- NASA's traditional mission development structure places responsibility on the mission teams to define the data management and utilization approach
  - Their focus is on mission science and on Level 1 requirements
  - Broader and more long term objectives are not included in this scope

We Have Chartered Earth Science Data Systems Working Groups (ESDSWG) to …

- Improve the consistency of mission data sets with clearer and more usable data standards
- Determine what enabling technologies we should be investing in to enhance the current ground systems to be ready by 2020 to handle the flood
- Help define methods to evolve the existing structure so the new systems being defined, by mission teams, can reuse existing approaches while meeting new demands
- Help define ways to improve data product continuity across platforms and generations of satellites to show operational users how we can provide seamless, quality information
- Improve mechanisms for exchanging key information with new mission teams to influence & guide their developments in the right path

Conclusion

- The NASA flight program invests ~$1B+/year in its flight missions
  - Satellite development, operation of missions, EOSDIS and other DACs, competed mission science teams
- While our mission development teams are focused on primary science, the missions are capable of returning so much more
- It becomes a question of

Requirements vs. Capabilities

- We are looking for ways to redirect or refocus some small part of our design activities to ensure we will retain as much capability as we can, knowing what the communities want
- We also are working with our partners to leverage their capabilities

ESD following through …

- At the **Project** level we are …
  - Holding mission specific applications workshops
  - Adding partners to our Science Definition and science teams
  - Adding specific applications requirements to the Level 1 mission performance requirements

- At the **Program** level we are …
  - Conducting cross disciplinary applications workshops
  - Encouraging greater coupling between airborne science, EV activities, R&A campaigns and applied sciences

- At the **Division** & **Agency** level we are …
  - Developing MOUs between Agencies to foster collaboration
  - Supporting GEO, GEOSS, CEOS and related international coordination activities on data standards

Purposes of the meeting:

A) learn more about the planned and Decadal Survey missions

B) discuss ideas for new applications related to these missions, and

C) discuss and provide feedback to NASA on needs and concerns.

Possible Topics to Consider and Discuss

1. On-going involvement of conservation community
2. Future workshop topics
3. Representation at Science Team Meetings
4. Connections with other key communities
5. Staying abreast of mission development and periods to provide input during mission development
6. Complementary assets to enable applications